(b) A square framework formed of uniform heavy rods of equal weight W joined together, is hung up by one corner A. Weight W is suspended from each of the three lower corners and the shape of the square is preserved by a light rod along the horizontal diagonal. Using principle of virtual work, find the thrust of the light rod. (9)

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December 2023 (Re-Appear)

B.Sc. (Hons.) Mathematics - V SEMESTER

Statics (BMH-501)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART–A

1. (a) State parallelogram law. (1.5)

(b) State converse of Lami's theorem. (1.5)

(c) State Varignon's Theorem. (1.5)

(d) At what angle, forces of magnitude 8 N and 3 N must act so that their resultant is of magnitude 7 N. (1.5)

(e) Define angle of friction and coefficient of friction. (1.5)

(f) Where center of gravity of a uniform triangular lamina located? (1.5)

(g) State principle of virtual work. (1.5)

(h) Define Poinsot's central axis. (1.5)

(i) Define wrench. (1.5)

(j) What do you mean by stable and unstable equilibrium? (1.5)

PART–B

2. (a) State and prove $\lambda - \mu$ theorem. (6)

(b) A heavy uniform rod 1.5 m long rests horizontally on two pegs which are 90 cm apart, a weight of 20 kg suspended from one end or a weight of 120 kg suspeneded from the other end will just tilt the rod up. Find the weight of the rod and the distance of the pegs from the center of the rod. (9)

3. (a) Define couple. Prove that the algebraic sum of moments of the forces forming a couple about any point in their plane is constant. (6)

(b) A beam of weight W is divided by its centre of gravity G into two portions AG and BG whose lengths are a and b respectively. The beam rests in a vertical plane on a smooth floor AD and against a smooth vertical DB. A string is attached to a hook at D and to the beam at a point C such that CD $\perp$ AB. If T be the tension of the string, θ and ϕ be the inclinations of the beam and the string respectively to the horizon, show that $T = \dfrac{W a \cos\theta}{(a+b)\sin(\theta - \phi)}$. (9)

4. (a) Forces P, 3P, 2P and 5P act along the sides AB, BC, CD and DA respectively of a square ABCD. Find the magnitude and direction of their resultant. (6)

(b) A uniform ladder of length l rests on a rough horizontal ground with its upper end projecting slightly over a smooth horizontal rail at a height a. If the ladder is about to slip and λ is the angle of friction with the ground, prove that $\tan\lambda = \dfrac{a\sqrt{l^2 - a^2}}{l^2 + a^2}$. (9)

5. (a) A hemisphere rests in equilibrium on a sphere of equal radius. Show that the equilibrium is stable or unstable according to the flat or curved surface of hemisphere is in contact. (6)

(b) Forces act along the edges of a regular tetrahedron *i.e.* P along BC and DA, Q along CA and DB, and R along AB and CD. Show that the pitch of the equivalent wrench is $\dfrac{1}{2\sqrt{2}}$ of the edge of tetrahedron. (9)

6. (a) Find the null point of the plane $x + y + z = 0$ for the force system (X, Y, Z, L, M, N). (6)

(b) Three equal forces act on a rigid body at (a, 0, 0), (0, b, 0), (0, 0, c) parallel to Y, Z and X-axis respectively. Find the resultant wrench and central axis. (9)

7. (a) ABC is an equilateral triangle of side 40 cm. Weights 5, 1, 3 Kgs. are placed at points A, B and C respectively and weights 2, 4 and 6 Kgs. are placed at the middle points of BC, CA and AB repectively. Find the distance of center of gravity from B. (6)